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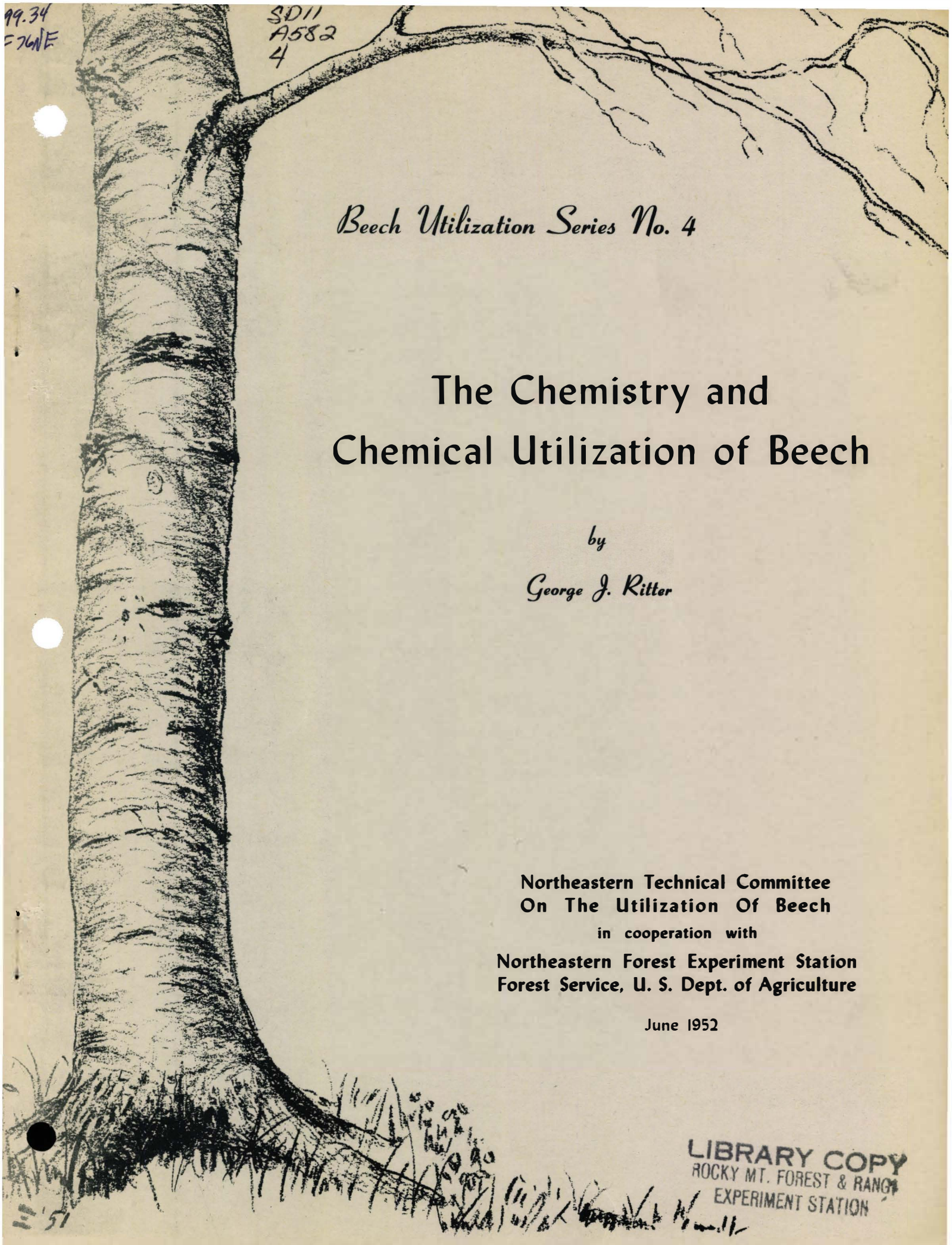

Beech Utilization Series No. 4

The Chemistry and Chemical Utilization of Beech

by

George J. Ritter

Northeastern Technical Committee
On The Utilization Of Beech
in cooperation with
Northeastern Forest Experiment Station
Forest Service, U. S. Dept. of Agriculture

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FOREWORD

The wood of the American beech tree (Fagus grandifolia Ehrh.) is well suited for a large number of uses, and it is rather widely used by manufacturers. Yet the amount used is not in proportion to the amount that grows in our northeastern forests. The utilization of beech--both in the woods and in the factory--has been recognized as a problem.

One reason for this is in the nature of the wood: it has a reputation for being difficult to season. Another is that many of the beech trees in our forests are of poor quality. And there are some plain prejudices against beech.

Research is finding ways to utilize beech as efficiently as any of the other comparable hardwoods can be handled. Considerable information about beech has been gathered. Yet most of this information is available only in fragmentary form in scattered technical reports. Some of it has never been published.

To study the problems of putting beech to the uses it deserves, and to promote the better management of the forests in which it grows, a Northeastern Technical Committee on the Utilization of Beech was organized in 1949. This committee, which includes representatives of Federal and State forestry agencies, universities, and state experiment stations, decided to assemble and publish the available information about the utilization of American beech.

As its part of this cooperative project, the Northeastern Forest Experiment Station has undertaken to edit, publish, and distribute the series of reports that will contain this information.

The subjects of these reports will be as follows:

* Physical and mechanical properties of American beech.

(CONTINUED ON INSIDE OF BACK COVER)

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THE CHEMISTRY AND CHEMICAL UTILIZATION OF BEECH

by

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BEECH IS USED EXTENSIVELY in the manufacture of well-known lumber products, but information about the chemistry and chemical uses of the wood is scant. This report was prepared at the U. S. Forest Products Laboratory to provide a source of information for those who are interested in the chemical composition and utilization of the species.

COMPOSITION OF BEECH WOOD

Summative Analysis

One way to study wood is by a summative chemical analysis. In this kind of analysis the four primary chemical elements of wood--extractives, ash, lignin, and holocellulose--are isolated and the weight of each is determined as a percentage of total weight.

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[1] MAINTAINED AT MADISON, WIS., IN COOPERATION WITH THE UNIVERSITY OF WISCONSIN.

Such an analysis was made of beech wood. In this analysis beech wood was compared with the wood of yellow birch and sugar maple, two hardwoods that are commonly associated with beech (table 1). The data show clearly that in chemical make-up beech is similar to birch and maple.

In this summative analysis the extractive component was broken down at the outset into two subcomponents: the materials soluble in hot water and the materials soluble in alcohol-benzene solution. This procedure shows up immediately any important differences in kind of extractives.

This analysis was carried forward to show the differences between sapwood and heartwood. The data (table 2) show that beech sapwood contains a greater proportion of extractives than heartwood, that the heartwood contains more ash and a little more lignin, and that sapwood and heartwood contain almost the same proportions of holocellulose.

Extractives form no part of the wood structure. In general, they can be removed from the wood by neutral solvents such as water, alcohol, ether, alcohol-benzene solution, and acetone. Extractives impart color, odor, taste, decay-resistance, and corrosive properties to wood. After they have been removed, an extractive-free wood residue remains.

This residue contains the structural elements--the fibers, wood rays, and vessels. It also contains most of the minerals that make up the ash, which is left after burning the lignin and holocellulose. Any one of the three structural components, if isolated carefully, will retain the microstructural pattern and shape it had in the original wood specimen (16).[2]

Proximate Analysis

Next, more intensive analyses of the four primary components of beech wood were made (1). In these analyses, wood samples were subjected to separate extractions with cold water, hot water, alcohol-benzene, and ether (table 3). Here too sapwood and heartwood were analyzed separately (table 4).

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[2] NUMBERS IN PARENTHESES REFER TO LITERATURE CITED, PAGE 15.

Extractives

Cold-water-soluble extractives include tannins, sugars, coloring matter, and salts. Hot-water-soluble extractives are similar; they also include starches. Thus the two water-soluble subdivisions of the extractives overlap. Both occur in greater concentrations in the sapwood than in the heartwood of beech.

Ether-soluble extractives include oils, fats, fatty acids, resins, resin acids, phytosterol, and waxes. The alcohol-benzene extractives are similar to those soluble in ether; they also include tannins. Alcohol-benzene extractives are present in larger amounts in the sapwood than in the heartwood of beech. Ether-soluble extractives are more concentrated in the heartwood.

Ash

Ash makes up 0.4 percent of whole beech wood by weight (table 5). Like most other wood ashes, beech ash is rich in potash. Other constituents of beech ash, expressed as oxides, are phosphorus, calcium, magnesium, iron, sulfur, silicon, and sodium.

The chemical elements found in beech ash indicate that it would be useful as a fertilizer--with the addition of an ingredient that contains available nitrogen. Potash promotes development of carbohydrates such as cellulose and starch in plant growth; it is necessary for growth of strong plant stems and good fruit and seed. It is especially useful for growing large potatoes. Phosphorus is also important in production of fruit and seeds.

Lignin

Beech has a lignin content of 21.0 percent. In this it is intermediate to birch and maple (table 3). The lignin content of beech heartwood is slightly greater than that of the sapwood (table 4).

Functionally lignin forms about 85 percent and hemicellulose 15 percent of a connective tissue (middle lamella) that binds the fibers and other structural elements of wood together (15). Lignin is also diffused throughout the cellulose in the fiber wall. It is at a high concentration in

Table 1.--Data from summative chemical analysis of wood (1)

(Based on weight of oven-dry wood.)

Species	Extractives soluble in--		Ash	Lignin	Holo-cellulose	Total
	Hot water	Alcohol-benzene				
	Percent	Percent	Percent	Percent	Percent	Percent
Beech	1.5	1.0	0.42	21.0	76.5	100.42
Birch	1.3	1.4	.40	19.3	77.0	99.40
Maple	1.1	1.2	.42	22.3	75.2	100.22

Table 2.--Comparison of sapwood and heartwood in summative chemical analysis (1)

(Based on weight of oven-dry wood.)

Species	Extractives soluble in--		Ash	Lignin	Holo-cellulose	Total
	Hot water	Alcohol-benzene[1]				
	Percent	Percent	Percent	Percent	Percent	Percent
Beech						
Sapwood	2.17	1.37	0.31	20.61	76.20	100.66
Heartwood	.43	.96	.57	22.26	76.85	101.07
Birch						
Sapwood	1.30	.97	.11	18.56	79.50	100.44
Heartwood	1.29	1.89	.50	20.19	76.45	100.32
Maple						
Sapwood	2.08	1.31	.32	20.33	76.26	100.30
Heartwood	1.20	1.22	.84	21.79	75.96	100.01

[1] Extractives soluble in water and alcohol-benzene determined on original wood.

Table 3.--Data from proximate chemical analysis of wood (1)

(Based on weight of oven-dry wood.)

Species	Extractives soluble in--				Ash	Lignin	Holocellulose		Methoxyl	Acetyl	Pentosans	Crose and Bevan cellulose
	Cold water[1]	Hot water	Alcohol-benzene	Ether			Alpha-cellulose	Hemi-cellulose				
	1	2	3	4	5	6	7	8	9	10	11	12
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Beech	1.2	1.5	1.0	0.60	0.42	21.0	50.0	26.5	6.3	5.0	25.0	60.5
Birch	1.0	1.3	1.4	.30	.40	19.3	49.7	27.3	5.9	7.4	26.8	58.7
Maple	.7	1.1	1.2	.45	.42	22.3	50.0	25.2	6.4	5.5	22.3	60.4

[1] Each of the subcomponents of extractives determined on the original wood.

the middle lamella, gradually becoming less concentrated toward the fiber cavity.

Lignin adds stiffness to the structural elements. If it occurs in too-high concentrations the fibers become brittle, as in compression wood on the under side of leaning trees or large, drooping limbs. In contrast, tension wood, which occurs on the upper sides of leaning trees (2), has less lignin and more cellulose than normal wood.

Thin-walled springwood fibers that have been separated from one another by mechanical maceration remain inflated; but upon delignification they collapse to form ribbons. In their double-walled, ribbon-like condition the fibers are more flexible than in their normally inflated or tubular condition. This explains why chemically prepared pulp produces more flexible paper sheets than does mechanically prepared pulp such as groundwood or Asplund fiber.

Methoxyl, which is a minor chemical constituent, should also be mentioned. Beech wood is found to contain 6.3 percent of methoxyl (table 3, column 9). Roughly 85 percent of the methoxyl in wood is associated with the lignin; the remaining 15 percent is associated with the hemicelluloses and extractives.

Methoxyl is the nucleus of so-called "wood alcohol," technically known as methyl alcohol or methanol. Methoxyl has the chemical formula CH_3O. If a hydrogen atom is combined with methoxyl, methyl alcohol (CH_3OH) is produced. Thus, by removing methoxyl from the lignin of wood and combining it with hydrogen, it is possible to make methyl alcohol. This takes place in destructive distillation. Beech, birch, and maple wood have all been used extensively in this process. This subject will be discussed further under destructive-distillation products.

Since beech has a normal lignin content for hardwoods, logging and sawmill wastes undoubtedly can be pulped at about the same cost for beech as for birch and maple. Data obtained from chemical analysis, however, provide no information on the physical quality of the fibers.

Holocellulose

Holocellulose is a white, fibrous, lignin-free solid material (17). It has two subcomponents--alpha-cellulose and the hemicelluloses.

Table 4.--Analytical data on sapwood and heartwood (1)

(Based on weight of oven-dry wood.)

Analytical components	Beech		Birch		Maple	
	Sapwood	Heartwood	Sapwood	Heartwood	Sapwood	Heartwood
	Percent	Percent	Percent	Percent	Percent	Percent
Of wood:						
Ash	0.31	0.57	0.11	0.50	0.32	0.84
Extractives soluble in--						
Cold water	1.23	.23	1.20	.93	.81	.52
Hot water	2.17	.43	1.30	1.29	2.08	1.20
Alcohol-benzene	1.37	.96	.97	1.89	1.31	1.22
Ether	.20	.57	.36	.30	.10	.89
Acetyl	7.13	6.05	8.79	6.11	6.56	4.94
Methoxyl	6.25	6.44	6.01	6.04	6.34	6.50
Pentosans	25.55	24.49	26.89	26.87	22.78	22.98
Lignin	20.61	22.26	18.56	20.19	20.33	21.79
Cellulose	60.83	60.71	59.36	58.37	60.39	60.27
Holocellulose	76.20	76.85	79.50	76.45	76.26	75.96
Of holocellulose:						
Acetyl	5.15	4.76	6.13	5.81	5.12	4.05
Methoxyl	.95	1.24	1.31	.93	.83	.97
Pentosans	24.46	23.52	26.49	24.94	22.67	22.57

Table 5.--Chemical composition of ash from beech wood (19)

(Based on weight of oven-dry ash.)

Ash from--	Potassium oxide	Phosphorous pentoxide	Calcium oxide	Magnesium oxide	Iron oxide	Sulfur dioxide	Silicon dioxide	Sodium oxide
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Beech sapwood	41.0	4.6	26.7	14.4	3.5	4.1	1.3	1.1
Beech heartwood	38.7	1.5	33.3	12.8	2.1	3.9	2.1	.4

Table 6.--Chemical composition of bark (14)

(Based on weight of oven-dry bark.)

Component of bark	Beech	Birch	Maple
	Percent	Percent	Percent
Extractives soluble in--			
Hot water	4.0	5.9	2.9
Ether	1.2	1.7	2.5
Acid-alcohol	13.1	12.3	20.6
Total soluble materials	18.3	19.9	26.0
Ash	8.3	2.9	3.1
Lignin	37.0	36.5	35.7
Pentosans	13.7	16.6	14.4

Table 7.--Chemical composition of nuts[1] (20)

Kind of nute	Refuse	Edible portion					
		Moisture	Protein	Fats	Carbohydrates (Sugar and starch; crude fibers)	Ash	Fuel value per pound
	Percent	Percent	Percent	Percent	Percent	Percent	Calories
Beech	36.9	6.6	21.8	49.9	18.0	3.7	2,740
Butternut	86.4	4.5	27.9	61.2	3.4	3.0	3,370
Walnut	58.8	3.4	18.2	60.7	16.0	1.7	3,075

[1] Percentage yields are based on weight of oven-dry edible portions, except for refuse, for which percentage yields are based on weight of oven-dry shell plus edible portion.

Alpha-cellulose makes up about two-thirds of the holocellulose, or 50 percent of the wood (table 3). It is the major ingredient of paper. In purified form it is used extensively in the manufacture of explosives, synthetic textiles, and plastics.

The hemicelluloses make up one-third of the holocellulose, or 25 percent of the wood (table 3, column 8). They impart bonding properties to wood fibers in paper sheets and wet-formed board products prepared from crude wood fibers.

In yield of alpha-cellulose and hemicelluloses, beech compares favorably with birch and maple, which are acceptable for pulp. Since the total holocellulose yield of beech approximates that of birch and maple, the pulp yield of the three species should be comparable.

Acetyls are minor chemical groups associated with the hemicellulose component of the holocellulose. By weight they comprise 5.0 percent of beech wood, as compared with 7.4 percent and 5.5 percent of birch and maple respectively (table 3). They are more concentrated in the sapwood than in the heartwood of all three species.

COMPOSITION OF BARK

Analytical data on the composition of bark (14) from beech, birch, and maple are presented in table 6. Note that the hot-water solubility of beech bark is greater than that of the wood. So is ether solubility.

The ash content, 8.3 percent, is many times greater than that of the wood. Lignin content is also considerably greater. Except for the ash content, which is extremely high, the analytical data for beech bark approximate those for bark of birch and maple. No data are available for cellulose or holocellulose in the bark.

COMPOSITION OF BEECHNUTS

According to a report by J. Russell Smith (20) beechnuts have been used as feed for swine in the New England

Table 8.--Production of sugars, molasses, yeast, and alcohol from wood

(Based on weight of oven-dry, bark-free wood.)

Products	Beech	Birch	Maple
	Percent	Percent	Percent
On laboratory basis:			
Total sugars from sawdust	70.1	69.9	68.2
Fermentable sugars from sawdust	52.6	53.1	48.5
On pilot-plant basis:			
Total sugars from hogged wood	49.1	49.1	48.6
Fermentable sugars from hogged wood	32.1	32.3	32.0
Molasses from hogged wood	100.0	100.1	100.0
Yeast from hogged wood	--	--	25.2
Alcohol from hogged wood	15.35	15.45	15.3

Source: Data from Harris, Saeman, Leonard, and their associates. See Literature Cited.

Table 9.--Yields of pyroligneous acid, tar, and charcoal from wood (8)

(Based on weight of oven-dry wood.)

Species	Pyroligneous acid free of tar and moisture			Tars			Charcoal		
	Heart	Slab	Mean	Heart	Slab	Mean	Heart	Slab	Mean
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Beech	32.3	35.4	33.8	9.7	10.6	10.1	43.1	39.4	41.2
Birch	34.2	34.3	34.3	9.6	8.5	9.0	39.0	38.1	38.5
Maple	33.4	34.6	34.0	12.5	12.3	12.4	40.2	37.6	38.9

Table 10.--Methyl alcohol and acids obtained from heartwood and slabwood by destructive distillation (8)

(Based on weight of oven-dry wood.)

Species	Grown in	Methyl alcohol			Total acid as acetic		
		Heartwood	Slabwood	Mean heart and slab	Heartwood	Slabwood	Mean heart and slab
		Percent	Percent	Percent	Percent	Percent	Percent
Beech	Indiana	1.95	1.79	1.87	5.56	6.18	5.87
Birch	Pennsylvania	1.62	1.59	1.60	6.19	6.10	6.15
Maple	Pennsylvania	1.94	1.78	1.86	5.66	5.44	5.55

Table 11.--Distillation products from wood, wood cellulose, and cotton (9, 10)

(Based on weight of oven-dry materials.)

Products	Beech		Birch		Spruce		Pine		Cotton cellulose
	Wood	Cellulose	Wood	Cellulose	Wood	Cellulose	Wood	Cellulose	
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Charcoal	34.97	32.91	31.80	33.39	37.81	34.86	37.83	36.93	38.82
Tar	8.11	5.23	7.93	9.58	8.08	6.28	11.79	4.85	4.18
Acetic acid	6.04	3.50	7.08	3.89	3.19	2.79	3.50	2.18	1.39
Methyl alcohol	2.07	.19	1.60	--	.88	.07	.96	trace	--
Methane	.47	.39	.54	.47	.62	.22	.59	.27	.27

States. In some sections woodlands are fenced with woven wire and when the beechnut crop is ready the hogs to be fattened are turned into the enclosure. Smith reports that in Europe the wild boar and semiwild hogs also feed on beechnuts. Beechnut oil has been substituted for butter in Europe.

Beechnuts contain the constituents of a good food (table 7). They have 22 percent protein, 50 percent fats, and 18 percent carbohydrates. One pound of beechnuts, according to Smith, contains as much protein as 6.6 pounds of milk. On burning, one pound of beechnuts furnishes 2,740 calories of heat. On this basis 3 ounces of beechnuts will replace 20 ounces of milk in heat value.

CHEMICAL UTILIZATION OF BEECH WOOD

Wood Sugars

One possible way to utilize beech byproducts from logging and sawmill operations is to convert the waste materials into wood sugars by acid hydrolysis.

If holocellulose that has been isolated from the wood is treated with dilute sulfuric acid under controlled conditions, it can be converted almost quantitatively into a mixture of sugars and acetic acid. Some water enters into the chemical reaction and, as a result, the sugars obtained--plus the acetic acid--should theoretically weigh about 11 percent more than the holocellulose used. Under ideal conditions 100 pounds of cellulose material would produce about 110 pounds of sugar.

The sugars obtained from the alpha-cellulose portion of the holocellulose are mostly hexoses. Those obtained from the hemicellulose portion are mostly pentoses. The hexoses can be fermented to ethyl (grain) alcohol by yeast; the pentoses cannot.

When fine wood chips are hydrolyzed with acid, the holocellulose in them is partially protected by the lignin and extractives. As a result, some of the sugars are destroyed between the time the sugars form and the time they are removed from the acid medium. Furthermore, the acetic

acid of the holocellulose is liberated. Thus the yield of sugars obtained from sawdust, even in the laboratory under controlled conditions, generally is considerably below the theoretical.

The yield was even less when the hydrolysis was tried on a pilot-plant scale in a large digester (800 pounds capacity), using chips and hogged wood (18). Table 8 shows the yields obtained with both laboratory and pilot-plant methods (4, 5).

Molasses

In tests with this pilot-plant digester, wood sugars were found at about 4 percent concentration in the dilute acid-water solution drained from the digester. The acid was neutralized with calcium carbonate to convert the sulfuric acid to calcium sulfate, which was removed by filtration. From the neutralized sugar solution a molasses that has 50 percent sugars can be prepared by evaporating part of the water (3).

Beech wood yields about 50 percent sugars--1,000 pounds of sugar from 1 ton of wood. Accordingly it is possible to make 1 ton or 166 gallons (2,000 ÷ 12) of molasses having 50 percent sugar concentrations from 1 ton (dry weight) of beech wood (table 8). Molasses produced this way has been used in experimental feeding tests with chickens, hogs, and cattle. The results were promising.

Yeast

The yield of unfermentable sugars in a pilot plant at the U. S. Forest Products Laboratory was equal to 17 percent of the dry weight of the beech wood processed. These sugars, as well as the fermentable sugars, are suitable for growing yeast for stock feed. Yeast yields from the total sugar produced from maple wood in the pilot-plant were 25.2 percent of the sugars.

Although no beech sugars were used in the experiments for propagation of yeast, they appear to be suitable for yeast culture. Yeast is rich in proteins and vitamins and has been found suitable as a substitute for part of the protein requirements for stock feed.

Alcohol

Wood sugar produced from the alpha-cellulose portion of the holocellulose in wood is mostly all glucose. It is the same sugar that can be obtained from corn and cane and sugar beets. Yeast can convert this glucose into ethyl alcohol, the so-called "grain alcohol" that is present in beer and wine and is widely used in other commercial products (6, 7, 11). This should not be confused with the so-called "wood alcohol."

From the glucose of beech wood, ethyl alcohol can be produced that is equal in weight to 15 percent of the dry weight of the wood. On this basis, 1 ton of beech wood will produce 307 pounds--46 gallons--of ethyl alcohol.

DESTRUCTIVE-DISTILLATION PRODUCTS

If wood is heated in an oven from which air is excluded, the wood dries through the loss of free and adsorbed water. If the temperature is raised to 180° C. or higher, the wood begins to undergo destructive distillation, during which the so-called "water of constitution" is driven off. If the temperature is raised further, to about 270° C., the wood itself begins to decompose.

During this stage four groups of products are obtained: gases, pyroligneous acids, tars, and charcoal. These products are derived from the lignin and the holocellulose. Charcoal will not be discussed here; it will be the subject of another report in this series.

Gases

The gases include carbon dioxide, carbon monoxide, hydrogen, and methane. The first is an inert gas; the other three are combustible and can be used to produce heat. These gaseous products account for approximately 15 percent of the weight of the wood.

Pyroligneous Acid

The pyroligneous acid group--a solution of water-soluble products--comprises about 34 percent of beech wood

(table 9). By weight, water is the major constituent of the group. Acetic acid is the principal useful constituent. It is derived principally from the acetyl groups of the hemicelluloses. Some acetic acid may also be derived from cellulose; this will be discussed later. Yields of acetic acid by destructive distillation of beech approximate 6 percent of the dry weight of the wood (table 10); similar yields are obtained from birch and maple.

Methyl alcohol is also present in the pyroligneous acid group. Yield from beech wood approximates 2 percent of the dry weight of the wood (table 10). This accounts for about 33 percent of the methoxyl in the wood; the other 67 percent has been shown to occur as derivatives in the form of methane among the gases and methyl and methoxy derivatives of phenol in the tar group of destructive-distillation products (8).

Tars

Tars constitute about 10 percent of beech wood (table 9). In these tars have been found traces of formic, propionic, and valeric acids and phenolics. This indicates that some of the constituents of the pyroligneous acid also occur in the tars in minute amounts. Besides these acids, some other basic materials have been identified among the tar constituents. They include ammonia, methylamine, dimethylamine, trimethylamine, and pyridine and its methyl derivatives.

Fractions of the tars have been shown to have toxic properties--similar to those of coal-tar creosote--toward wood-destroying micro-organisms. Beech wood, because of the pleasing flavor-producing properties of its creosote, is considered comparable to hickory for smoking meats. Creosote prepared from beech tar is also used extensively in medicinal products.

Klason (9, 10) distilled some woods, the cellulose from the same woods, and cotton cellulose. He found (table 11) that beech wood yielded approximately 35 percent of its weight in charcoal, as compared with 33 percent produced by its cellulose. Spruce and pine wood also produced more charcoal than their celluloses did; birch wood was an exception. Cotton cellulose, on the other hand, produced greater yields of charcoal than any of the woods did.

With the exception of birch, the woods also produced more tars than did their celluloses or the cotton cellulose. Acetic-acid yields were greater from the woods than from their celluloses; this indicates that some of the acetyl was removed from the celluloses during their isolation from the wood. Methyl-alcohol yields were higher from the wood than from the celluloses, which is explained by the fact that only a small portion of the total methoxyls of the wood is associated with the cellulose.

CHEMICALLY MODIFIED WOODS

Beech and other woods have been modified by combinations of chemical and physical treatments so as to improve their properties for special use requirements. Beech was converted to two products known as "Lignostone" and "Lignofol" in Germany before World War II (13).

Lignostone

Solid, dry beech wood was cut to the required sizes, evacuated of air in a chamber, and impregnated with a solution of partially prepolymerized synthetic resin (such as Bakelite) at 100° C. under 6 to 8 atmospheres pressure. The temperature was gradually increased to 130° C. for 5 hours.

This treatment increased the density and part of the strength properties of the wood and imparted some moisture resistance and dimensional stability. The wood product has been put to use as parts for textile machines, bearing plates, beaters, wood hammers, railing, skiis, and cog wheels.

Lignofol

Lignofol was prepared from beech veneer. The veneer plies were glued together with a synthetic adhesive, which was applied to the surfaces of the plies and allowed to diffuse into the plies before high temperatures and pressures (5,000 pounds per square inch) were applied for curing the glue. The plies were arranged either parallel or with some cross-bonding, depending on the use requirements for the finished product.

This material has been put to use in airplane parts, machine parts for the textile industry, and molds and forms for use in the shaping of metals.

Impreg, Compreg, Staypak

Similar modified wood products have been developed by American research laboratories (21). They include Impreg, which is similar to Lignostone; Compreg, which is similar to Lignofol; and Staypak, a heat-stabilized, compressed wood that has been heated during the pressing process under conditions such that the compression is not lost when the wood subsequently swells. Although Staypak swells, it will return to practically its original compressed thickness on drying.

Beech wood has not yet been used in making Impreg, Compreg, or Staypak, but it is believed to be suitable for making them. Such products made from beech should have properties similar to those made from comparable hardwoods.

Wax Treatment

A wax treatment for beech was also developed in Germany (12). Solid beech wood was impregnated with a solution of montan wax dissolved in trichlorethylene. This was done in a tank, from which air was evacuated. The wood was impregnated with the warm solution at 130° C. and 8 atmospheres pressure until the desired amount of wax had been absorbed.

Excess pressure was then released and trichlorethylene vapor was generated by heating the tank. The vapor forced the excess solution into the supply tank, which was then shut off with a valve. The trichlorethylene vapor was distilled in a vacuum and passed into a condensing unit. The high vacuum and expansion of the residual air in the wood removed the trichlorethylene and water from the wood.

The author says that the treatment produces a wood product suitable for bobbins, beaters, cog wheels, frames for filter presses, tool handles, and shoe lasts.

SUMMARY

Results of a proximate analysis in which the four major components of beech wood were broken down into their subcomponents show that the percentages of extractives, ash, lignin, holocellulose, alpha-cellulose, hemicelluloses, methoxyl, acetyl, pentosans, and Cross and Bevan cellulose of beech wood closely approximate the percentages of the corresponding components of yellow birch and hard maple.

These findings indicate that beech is on a par with birch and maple for the production of alpha-cellulose for cellulose derivatives; for the production of wood sugars, molasses, yeast, and ethyl alcohol; and for the production, by destructive distillation, of methyl alcohol, acetic acid, and charcoal.

Beech bark, like the bark of birch and maple, has more than one-third of its weight in lignin. Beech bark is especially high in ash content.

Beechnuts are valuable as a food for animals such as hogs. They contain ample amounts of protein, fats, and carbohydrates.

Beech wood can be used successfully in the manufacture of modified wood products.

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(CONTINUED FROM INSIDE OF FRONT COVER)

* Chemistry and chemical utilization of beech.
Management of beech.
Beech availability and supply.
Present markets and uses for beech.
Methods of logging beech.
Seasoning of beech.
* Storage of beech logs and bolts.
Machining of beech.
Milling of beech.
Gluing of beech.
* Bending of beech.
Preservative treatment of beech.
Beech for flooring.
Beech for furniture.
Beech for turned products and novelties.
Beech for veneer and plywood.
Beech for fuel and charcoal.
Beech for cross ties.
Beech for containers.
Pulping and defiberization of beech.
Rough construction on the farm with beech.

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The information gathered in this widespread cooperative project should be of great use to the wood-using industries of the regions where the wood of American beech is available.

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*Reports published.